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DEEP-SEA DEPOSITS.

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873–76, *under the command of Captain George S. Nares, R.N., F.R.S., and the late Captain Frank Tourle Thomson, R.N.* Prepared under the Superintendence of the late Sir C. Wyville Thomson, F.R.S., and now of John Murray, LL.D., Ph.D., &c., one of the Naturalists of the Expedition. *Report on Deep-Sea Deposits, based on the Specimens collected during the Voyage.* By John Murray, LL.D., Ph.D., and the Rev. A. F. Renard, LL.D., Ph.D., Professor of Geology and Mineralogy in the University of Ghent. Pp. xxix. and 496; with 43 Charts, 22 Diagrams, and 29 Lithographic Plates. (London: Published by Order of Her Majesty's Government, 1891.)

GEOLOGISTS have had to wait long for this very important work, but now that it lies before them, we believe that the general verdict will be that it was worth while to wait even sixteen years for a monograph so excellent in design and so complete in execution. It must not be forgotten, too, that much of the information contained in this volume has been already given to the scientific world—first in Mr. Murray's Preliminary Report on the subject, published in the Proceedings of the Royal Society; and secondly in a series of papers written by him in conjunction with Prof. Renard, and published in the Proceedings of the Royal Society of Edinburgh.

It is a most fortunate circumstance that the naturalist on board the *Challenger*, who had charge of the collection, examination, and preservation of the samples of the deposits collected by the sounding-apparatus and the dredge, as well as of those obtained by means of the tow-nets and tangles, has been able during the long period that has elapsed since the return of the vessel to England, to devote his attention to their careful study and description. In the work of dealing with this vast mass of materials, as the preface informs us, Mr. Murray has had the cooperation of Mr. Frederick Pearcey, who accompanied the Expedition, and was afterwards assistant in the *Challenger* Office, and also of Mr. James Chumley. Especially fortunate has been the circumstance that Sir Wyville Thomson and Mr. Murray were, in 1878, able to secure the aid of the eminent Belgian petrographer, Prof. Renard, who is so great a master of those microscopic methods of research which have played no unimportant part in the development of geological science during recent years. In the exact determination of the minute fragments of minerals which occur in these deposits, Prof. Renard's knowledge of the optical and chemical methods of microscopic research has proved of especial value; and the assurance that, during several months in the years 1881 and 1882, the Belgian petrographer was able to devote himself to the work of investigating these deposits will invest the mineralogical determinations with an authority which they could not otherwise possess.

The introduction to the work consists of an excellent summary of the references contained in various authors, beginning with Herodotus, Plato, and Skylax, to the supposed nature of the sea-bottom. The sagacious remarks on the subject by the Italian naturalists, who were the real founders of the science of geology in the fifteenth century, receive appreciative notice; and the earliest attempts to deal with the deposits of the deep seas, especially those of Soldani, Ehrenberg, Sir Joseph Hooker, Edward Forbes, and Prof. J. W. Bailey, have full recognition. The important memoir of Prof. W. C. Williamson on the mud of the Levant is noticed; but the authors seem to be scarcely aware how many of the later discoveries in this branch of science were foreshadowed in the remarkable monograph of the Manchester Professor. A general account of the results obtained by the chief expeditions fitted out for the study of the deep ocean and its deposits—expeditions which preceded and followed that of the *Challenger*—leads up to a division of marine deposits into "Terrigenous" and "Pelagic," a classification which, if not too rigidly applied, appears to be serviceable and even necessary.

The first chapter is devoted to the various methods of obtaining, examining, and describing deep-sea deposits, and here the general arrangements made on board the *Challenger*, which are familiar to most readers from the description given by Sir Wyville Thomson in his "Voyage of the *Challenger*," and the narrative volumes of the Report, receive very full and exhaustive treatment. The precise account of the apparatus, illustrated as it is by numerous woodcuts, cannot fail to be of great value to those engaged in fitting out similar expeditions. The study of the methods employed in the sifting, fractional decantation, and chemical examination of the several deposits is essential to the proper understanding of the results detailed in succeeding chapters of the work. The methods of analysis employed by Prof. Brazier at Aberdeen, and by MM. Renard, Sipöcz, Hornung, and Klement, in the laboratory of Prof. Ludwig, of Vienna, and in M. Renard's laboratory at Brussels, are given in full detail, and will prove of great service when the results described in the present volume come to be compared with those of future investigators.

The second chapter consists of a series of synoptical tables, occupying 114 pages, in which the nature and composition of every deep-sea deposit collected during the voyage of the *Challenger* is described. In each case the number of the station, the date, the latitude and longitude, the depth in fathoms, the temperature at the surface and the bottom are given; and these particulars are followed by (1) a general description of the material brought up; (2) the percentage of calcium carbonate; (3) a list of the chief Foraminifera present; (4) an enumeration of the other calcareous organisms; (5) the percentage of insoluble residue; (6) a list of the siliceous organisms; (7) of the minerals; (8) a description of the fine washings; the last column being devoted to additional observations. These synoptical tables are followed by a discussion of the variation of the deposits with change of conditions along the different lines of soundings and dredgings. This general summary of the results, which occupies 36 pages of the work, constitutes an admirable *résumé* of the information contained in the tables.

Chapter iii. is devoted to the description of recent marine formations and the different types of deep-sea deposits: their composition, geographical and bathymetrical distribution. All marine deposits which are not "Littoral," or formed between high- and low-water marks, or "Shallow-water," a term which the authors limit to the interval between low-water mark and a depth of 100 fathoms, are classified in this work as deep-sea deposits. They include Coral Mud, Volcanic Mud, Green Mud, Red Mud, and Blue Mud (which are classed as Terrigenous Deposits, formed in deep and shallow water close to land-masses), and the Pteropod ooze, Globigerina ooze, Diatom ooze, Radiolarian ooze, and Red Clay (which are grouped as Pelagic Deposits, formed in deep water removed from land). In the case of each of these deposits the proportions and characters of the organic and inorganic materials are given, and the results of a large number of chemical analyses, some of which are now published for the first time, are discussed. Perhaps one of the most interesting of the many valuable discussions contained in this chapter is that which deals with the proportions of the ocean-floor covered by different kinds of deposits. A map (Chart I.) is devoted to an attempt to illustrate the nature of the ocean-floor over the whole of the globe, and we cannot resist the temptation of quoting the general estimate to which the authors have been led by their laborious and patient researches. These results are based not only on the collections made during the *Challenger* Expedition, but on many obtained before and since, which have all passed through the hands of the authors; they include the materials brought up in no less than 1600 soundings from the Atlantic, 300 from the Indian Ocean, and 400 from the Pacific, all from depths exceeding 1000 fathoms. It is evident, therefore, that the map and estimates, though admittedly only approximate, are based on a mass of data such as has never been brought together before.

The total area of the surface of the globe is estimated at 196,940,700 square miles, of which dry land occupies about 53,681,400 square miles, and the waters of the ocean 143,259,300 square miles. The approximate extent of the areas of the sea-floor occupied by each type of marine deposits is given as follows:—

		Mean depth in fathoms.	Area in square miles.
	"Littoral Deposits"	—	62,500
	Shallow Water Deposits	—	10,000,000
Terrigenous Deposits.	Coral Mud	740	2,556,800
	Coral Sand	176	
	Volcanic Mud	1033	600,000
	Volcanic Sand	243	
	Green Mud	513	850,000
	Green Sand	449	
	Red Mud	623	100,000
	Blue Mud	1411	14,500,000
Pelagic Deposits.	Pteropod ooze	1044	400,000
	Globigerina ooze	1996	49,520,000
	Diatom ooze	1477	10,880,000
	Radiolarian ooze	2894	2,290,000
	Red Clay	2730	51,500,000

Some of the most striking results, which make themselves apparent from a study of this estimate and the accompanying chart, are the very wide distribution of the Foraminiferal ooze and the red clay in the Atlantic and Pacific respectively; and the remarkable manner in which the deposits of vegetable origin replace those composed of the remains of animals on the bottom of the Antarctic Ocean.

Chapter iv., dealing with the materials of organic origin, is, we are informed in the preface, entirely from the pen of Mr. Murray. The Reports of the late Mr. H. B. Brady, of Prof. Haeckel, and of Count Castracane, on the Foraminifera, the Radiolarians, and the Diatomaceæ brought home by the *Challenger* Expedition, have already supplied naturalists with the means of drawing many important deductions; but Mr. Murray still finds much to say on the subject, which is not only new, but of very great interest. In the couple of pages devoted to the description of those curious and abundant organisms the Coccospheres and Rhabdospheres, which Mr. Murray here refers without doubt to the Calcareous Algæ, we could have wished that he had been able to announce that he had succeeded in inducing some competent botanist to undertake the study of the material brought home. One of the most important discussions in this chapter is that on the disappearance of calcic carbonate in the deeper deposits. The estimate made by Mr. Murray of the mean percentage of calcic carbonate in the different deposits, as the result of a large number of chemical analyses, is as follows:—

	Percentage of $CaCO_3$.
Coral Mud and Sand	86·41
Pteropod ooze	79·26
Globigerina ooze	64·53
Diatom ooze	22·96
Blue Mud and other Terrigenous deposits	19·20
Red Clay	6·70
Radiolarian ooze	4·01

The facts cited by Mr. Murray, on the authority of Mr. John Rathay (p. 282), on the ease with which the remains of the Diatomaceæ are dissolved, are of especial importance to the geologist who is called upon to explain the origin of the silica now forming nodules and bands in beds of limestone, and which he is tempted to refer entirely to the larger organisms like Siliceous Sponges, because remains of these are sometimes preserved. All the observations made in the existing deep seas, however, point to the conclusion that the minute Diatoms and Radiolarians play a much more important part in separating the soluble silica from sea-water than do the Siliceous Sponges.

Chapter v., dealing with the mineral substances found in deep-sea deposits, is full of interest. The mineral particles which are obviously derived from the solid crust of the globe are first dealt with, and in the account of the pumice, the basic volcanic glass, and the palagonite of the deep-sea deposits, Prof. Renard exhibits alike his wide mineralogical knowledge and his skill in dealing with microscopical and often obscure materials. The coloured lithographic plates illustrating this part of the work, which have been drawn by Prof. Renard, and engraved in Vienna, are of wonderful beauty and fidelity. A list of mineral particles detected in deep-sea deposits is given, and includes all, or nearly all, the common rock-forming minerals; but it is admitted that, with respect to the very minute particles in the finest washings, a considerable margin of doubt must always exist regarding their identification. We could wish that it were possible, in the space at our command, to give a summary of the facts leading to the conclusion that materials of extra-terrestrial origin play a not unimportant part in the accumulations which are taking place on the deepest ocean-floors. We can only call attention, however, to the clear descriptions and admirable plates which illustrate this part of the subject. The exquisite drawings of magnetic spherules and of chondre upon Plate xxiii., enable the reader to judge of the real nature of the evidence relied upon, and an examination of these figures cannot but remove any lingering doubt, as to the true nature of these materials, from the minds of all those who are familiar with the minute structure of meteorites.

The last chapter of the work deals with the chemical products which are formed *in situ* upon the floor of the ocean, and here, perhaps, the interest of the work for the geologist culminates. We can only refer to the numerous and interesting problems connected with the origin of the red clay, the mode of formation of the glauconite-casts, the source of the materials and the chemical processes involved in the formation of the phillipsite and other zeolites, the manganese-nodules, and the phosphatic and other concretions. The 76 pages of text, and the admirable drawings which illustrate this part of the subject, will excite the interest of all students of the subject. They enable the reader to form a clear idea of the forms and structure of the remarkable manganese nodules, and of the ear-bones, teeth, and other objects which, in a more or less phosphatized condition, are strewn over the deepest part of the ocean-floors. In an appendix is given a report on the analysis of the manganese-nodules by Dr. John Gibson, especial attention being directed to the detection of the rarer elements by spectroscopic and other methods. While traces of barium, strontium, lithium, molybdenum, zinc, titanium, vanadium, and thallium were found, cæsium, rubidium, and the metals of the cerium and yttrium groups were sought for in vain. The quantitative analyses, as shown by the tabular statements, would appear to have been executed with every modern refinement, and were carried out, by Prof. Crum Brown's permission, in the Chemical Laboratory of the University of Edinburgh. Another appendix contains an account of the analyses which have been made of the different varieties of deep-sea deposits.

In conclusion, we may point out that the work is worthy of praise, not only for what it includes, but for what it omits. The time has not yet arrived for a full discussion of the geological bearings of many of the new and interesting facts brought to light by the *Challenger* Expedition. Theoretical discussions are, therefore, wisely kept, in the monograph before us, within very narrow bounds. It is evident that much of the work was written before the publication by Messrs. Jukes-Browne and Harrison of their interesting memoirs on the geology of Barbadoes, and before the discovery of the Radiolarian-chert of Ayrshire and other districts. These discoveries, it is true, are mentioned in footnotes, but have evidently had but little influence in moulding the views of the authors. Few geologists will be prepared to accept the views of Mr. Murray, when he endorses the conclusion of M. Cayeux that the white chalk should be classed as a terrigenous deposit. But on this and other points the views of the authors are stated with a commendable absence of dogmatism, and a manifest desire to lay before readers of the work all the facts bearing upon the questions at issue, even when they are manifestly hostile to the conclusions adopted.

We cannot bring this notice to an end without congratulating the editor of the *Challenger* Reports on the nearly approaching close of his heavy labours. Only by a worker gifted with unrivalled powers of organization, as well as with indomitable energy, could such a task have been brought to a successful termination. The mass of materials was so vast and multifarious, the interests involved in their distribution so wide and often conflicting, while personal considerations could not always be kept from exercising a disturbing influence, that it is less surprising that criticism should sometimes have been provoked, than that results so substantial, and, on the whole, satisfactory, should in the end have been attained.

The present Report forms the last of the series of splendid monographs in which the results of this famous Expedition—one which will be recorded in the history of Science as perhaps the grandest concession to her claims made up to the present time by the British or any other Government—are fully recorded and discussed. The final volume of the *Challenger* Reports, which, it is stated, will probably be published in the course of the present year, will contain lists of the organisms collected at every observing station, with other details, in the nature of a summary of results. JOHN W. JUDD.

PARASITIC FUNGI AND MOULDS.

British Fungi: Phycomycetes and Ustilagineæ. By G. Massee. (London: Reeve and Co., 1891.)

IT is a somewhat remarkable fact that no one has hitherto written a book on the British *Phycomycetes*, the common white moulds so often found growing on decaying substances or in water, or as parasites of a most destructive kind in various valuable plants; and the opportunity thus afforded to the writer of the present volume was a good one, of which, it is but fair to say, he has taken considerable advantage. The *Ustilagineæ* of this country had already been treated by Mr. Plowright, but there are sufficient differences between the works of the two authors to make Mr. Massee's book none the less noteworthy on that account.

When we consider the great variety of "white moulds," such as *Mucor*, that infest all kinds of rotting fruits and other vegetable *débris*, of parasites such as the *Phytophthora* of the potato disease, and the *Peronosporeæ* which destroy onions, vines, and other valuable vegetable produce, to say nothing of the *Saprolegnia* of the salmon disease, the *Pythium* which decimates seedlings of all kinds, and the *Empusa* which kills our house-flies in autumn, and glues their dead bodies to the window-panes —when we regard these and a host of other extraordinary and important *Phycomycetous* Fungi, it seems more and more surprising that no one has compiled an intelligible account of these things in this country; yet so it is, and the author of this little book of a couple of hundred of pages of carefully, and, on the whole, pleasantly-written matter, ought certainly to deserve the thanks of botanical readers for undertaking the difficult task, and discharging it as well as he has done.